Simon Stevin and the Art of War

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1. General Introduction

To a general educated public Simon Stevin is mainly associated with the introduction of the decimal fractions, which led later on to the foundation of the decimal system of weights and measures. He realised numerous technical inventions out of which the construction of a 28-passenger sailing carriage used along the seashore was best known to his contemporaries.

Figure 1: Token with the portrait of Simon Stevin, Penningkabinet Koninklijke Bibliotheek Brussel, afb. 3 in “Simon Stevin, De geboorte van de nieuwe wetenschap”.

Caption: One-sided silver token, casted in 1607, 65 mm. This is the only portrait made of Stevin during his life. The artist is unknown.

For those less familiar with Stevin we recall[1] that he was born in Brugge (now Belgium) in 1548 as the illegitimate child of Anthuenis (Anton) Stevin and Catelyne (Catherine) van der Poort[2]. Recent studies[3] prove that his father was a cadet son of a burgomaster (mayor) of Veurne; his mother was the daughter of a burgher family of Ieper (Ypres), who married later a merchant in carpet-weaving and silk-trade, who belonged to a family with sympathy for the Calvinism religion[4]. Practically nothing more is known of Stevin's youth and education. He was at first employed in Antwerp as a bookkeeper and cashier in one of the trading-firms; there he became acquainted with business techniques. In 1577 he accepted a post at the financial administration of the jurisdiction of Brugge (Brugse Vrije). A few years later he is registered at Leiden (now The Netherlands). The reasons for this emigration, possible aversion for the Spanish oppression of the southern part of the Low Countries, or protestant sympathies, are not known. In 1583 we find him inscribed on the roll of the just founded University of Leiden, where he made the acquaintance of the young prince Maurits (Maurice) of Orange. A lifelong friendship developed between the two men: Prince Maurice found in Stevin an excellent tutor and later a capable and loyal counsellor; on the other hand Stevin could always reckon on support and protection of his princely friend. Prince Maurice, elected in 1584 as stadtholder of Holland and Zeeland, appointed Stevin in his personal service. Some sources quote Stevin as Quarter-Master General of the States' army (Staatse Leger). Recently one has discovered in the Public Record Office (Rijksarchief) of The Hague a journal and corresponding ledger, identified as an application in the year 1604 - by Stevin - of his ideas on "princely" bookkeeping, containing as an entry Stevin's annual salary of 600 Dutch guilders[5]. This high amount confirms the high status of Stevin at the court of the Prince. In 1600 Stevin, on initiative of the Prince, founded within the University of Leiden a

[1] Schouteet, A., De afkomst van Simon Stevin en diens werkkring in Vlaanderen , *Handelingen van het Genootschap ‘Société d Emulation’ te Brugge,* 80 (1937), pp. 137-146.
[2] Brugge, Stadsarchief, Oud Archief, reeksnr. 198, Protocollen van de klerken van de vierschaar, nr. 306.
[3] Donche, P., Voorouders van de wiskundige Simon Stevin te Veurne, *Vlaamse Stam,* 48 (4-5) (2002), pp. 178-199; Van Acker, J., De Veurnse voorouders en verwanten van Simon Stevin , *Liber Amicorum Roger-A. Blondeau,* Roesbrugge-Haringe (1999), pp. 265-280.
[4] Vandamme, L., *De socio-professionele recrutering van de reformatie te Brugge , 1566-1567,* licentiaatsverhandeling KULeuven, 1982, pp. 242-248.
[5] Zandvliet,K.,*Maurits, Prins van Oranje,* (exhibition catalogue), Amsterdam, 2000.

school of engineering, where the courses were taught in the Dutch (Nederduyts) language. Several authors mention that Stevin has travelled extensively through Europe. Unfortunately there exists only one known record of such travel. It concerns a visit to Dantzig [6] (now Poland), where Stevin was invited to give his expert advice on harbour-works. Around 1614 Stevin married young Catherine Cray; they had four children: Frederic, Hendrik, Susanna and Levina. It was his second son, Hendrik who published some posthumous work of his father. Stevin died at The Hague between February 20 and the beginning of April 1620, probably in his house at the Raamstraat, which he had bought in 1612 for 3800 Dutch guilders[7].

Figure 2: Oil-painting of Stevin, Leiden, Universiteitsbibliotheek, office of C. Van den Heuvel, icones 40.

Caption: Portrait of Simon Stevin, oil colours on panel, 82 x 68 cm. On the upper left one can read the place and date of birth, Brugge 1548, at the upper right the place and date of death, Den Haag 1620. The text under the portrait: Simon Stevin, excellent mathematician, advisor of the Prince Maurice.

Figure 3: The house of Stevin; figure 2.10 in “Wonder is gheen wonder, De geniale wereld van Simon Stevin”, foto Guido Vanden Berghe.

Caption: The house of Simon Stevin in Den Haag, Raamstraat 42, where Stevin lives with his wife Catharina Craiy and their four children.

There still exists an important interest for those contributions and endeavours of Stevin which have been recognised as pioneering or influential since a long time. One of the first books Stevin published was "Tafelen van Interest" [8] (Tables of interest, 1582), in which - for the first time in Western Europe- interest-tables were made public. Before that time only manuscripts were available, of which copies were sold at very high prices to tradesmen, merchants and bankers. It is without doubt that Stevin introduced for the first time a complete and systematic description of decimal fractions and the operations which can be carried out with them in a booklet, "De Thiende" [9] (the Tenth, 1585). It also treats the practical application of decimal fractions to the surveying of land, to the measurements of weights and to the partition of money. The English translation by Robert Norton (London 1608), "Disme, The Arts of Tenths or Decimal Arithmetike", has inspired Thomas Jefferson when he proposed a decimal monetary unit for the newly created United States of America. The tenth of the present dollar is still called a dime today. The Scottish Laird and mathematician, John Napier was inspired by Stevin's work for the invention of logarithms. In his works on physics Stevin introduced new original ideas. The study of statics of rigid bodies is exposed in "De Beghinselen der Weegconst" [10](Principles of Statics, 1585). It contains the fabulous "clootcrans" theorem, an ingenious *Thought Experiment*, by which the condition of equilibrium of weights on an inclined plane is obtained. As a consequence of this theorem Stevin succeeded in obtaining the sum of two concurrent forces by the parallelogram rule. In "De Beghinselen des

[6] Woelderink, B., *Het bezoek van Simon Stevin aan Dantzig in 1591,* Tijdschrift voor de geschiedenis der Geneeskunde, Natuurwetenschappen, Wiskunde en Techniek, 3 (1980) pp. 178-186.
[7] Dijksterhuis, E.J., *Simon Stevin*, ’s Gravenhage, 1943.
[8] Stevin, S., *Tafelen van Interest, midtsgaders de contructie der selver, ghecalculeert door* Simon Stevin Brugghelinck, T’Antwerpen, By Christoffel Plantijn in de gulden Passer, 1582.
[9] Stevin, S., *De Thiende leerende door onghehoorde lichticheyt allen rekeningen onder de menschen noodich vallende afveerdighen door heele ghetalen sonder ghebrokenen. Beschreven door* Simon Stevin *van Brugghe,* Tot Leyden, By Christoffel Plantijn, 1585.
[10] Stevin, S., *De Beghinselen der Weeghconst duer* Simon Stevin *van Brugghe,* Tot Leyden, In de Druckerye van Christoffel Plantijn, By Françoys van Raphelinghen, 1586.

Waterwichts" [11] (Principles of Hydrostatics, 1586) Stevin gives an improved demonstration of Archimedes' law, stating that a body immersed in a fluid undergoes an upwards force and determining it. He also succeeds in calculating the force a fluid exerts on the bottom of the vessel in which it is contained, which leads him to the formulation of the so-called hydrostatic paradox, many years before this was done by Blaise Pascal, to whom the paradox is usually attributed. Stevin published in 1586 his experiment in which two lead spheres, one 10 times as heavy as the other, fell from a height of 30 feet probably in Delft (Holland) in the same time. His report preceded by three years Galilei's first treatise concerning gravity and by 18 years Galileo's theoretical work on falling bodies.

Stevin was also a great mathematician. As all scientists of the Renaissance he was active, as already shown, in many disciplines. His innovating mathematical work dates from 1582 up to 1585. In that short period he calculates his interest tables; the theory behind these tables is very clearly developed and explained. In his "The Tenth" he introduced all operations - addition, subtraction, multiplication, division and the calculation of square roots - on decimal fractions, a real novelty for that time. In his work "L' Aritmetique" [12] - the only work written in French - he gives a review of the algebra knowledge of his time. He introduces new ideas and new theories in algebra and describes a numerical method for finding a zero real root of an function. In his "Problematum Geometricorum" [13], his only work written in Latin, the geometry, known at the end of the 16^{e} century is discussed. In his "Wisconstige Gedachtenissen"[14] (Mathematical Memoirs, 1605-1608) he gives a pedagogically very well documented review of mathematics in general.

Figure 4: Portrait of Prince Maurice, painting of Michile Jansz. Van Mierevelt, Rijksmuseum Amsterdam (zie figure 2.8 in "Wonder is gheen wonder, De geniale wereld van Simon Stevin".

Caption: Maurice, Prince of Orange (1567-1625) was an important friend of Simon Stevin. Stevin instructed him in many scientific problems and advised him in many military issues,

From 1590 on Stevin is mainly working in the service of Prince Maurice. The exhibition in the "Rijksmuseum", Amsterdam entitled "Maurice, prins van Oranje (2000)" [15] contributes to a better insight in the Stevin-Maurice interaction. The catalogue accompanying this exhibition describes many details of this relationship. Most of Stevin's publications from 1590 on are devoted to subjects of interest to his friend or to the nation. In 1590 he published a booklet "Vita Politica. Het Burgherlick leven" [16] (Civil life) in which he exposes how a citizen as a good subject should comply with the rules of the authorities. At that time the Republic of the Provinces of the Netherlands was being organised and with this publication Stevin aims at order and regularity. In the same spirit Stevin published two books of practical use for the defence of the country and for the extension of the fleet. In "De Sterctenbouwing" [17] (The construction of fortifications, 1594) the new way of fortification following the Italian system

[11] Stevin, S., *De Beghinselen der Waterwichts duer* Simon Stevin *van Brugghe,* Tot Leyden, In de Druckerye van Christoffel Plantijn, By Françoys van Raphelinghen, 1586.
[12] Stevin, S., *L'Arithmetique de* Simon Stevin *de Bruges:(…),*A Leyde, De l'Imprimerie de Christophle Plantin, 1585.
[13] Stevin, S., *Problematum Geometricorum in gratiam D. Maximiliani, Domini a Cruningen etc. editorum, Libri V, Auctore* Simone Stevinio *Brugense,* Antverpiae, Apud Ioannen Bellerum ad insigne Aquilae aureae, 1583.
[14] Stevin, S., *Wisconstige Gedachtenissen, inhoudende t'ghene daer hem in gheoeffent heeft den doorluchtichsten Hoochgeboren Vorst ende Heere, Maurits, Prince van Oraengien, etc., Beschreven duer* Simon Stevin van Brugghe, Tot Leyden, In de Druckerye van Jan Bouwensz, Int Jaer 1608.
[15] See reference 5.
[16] Stevin, S., *Vita Politica, Het Burgerlick leven, beschreven duer* Simon Stevin, Tot Leyden, By Francoys van Ravelenghien, 1590.
[17] Stevin, S., *De Sterctenbouwing beschreven door* Simon Stevin *van Brugge,* Tot Leyden, By Françoys van Ravelenghien, 1594.

was accommodated to the geographical conditions and the available means of the Low Countries; in this way Stevin's name remains associated with the so-called old Dutch method of fortification. This book was probably used as course material in the engineering school. In the second book, "De Havenvinding"[18], (literally: “harbour finding”, in fact dealing with position finding, 1599) Stevin describes the determination of a place on earth by the knowledge of the geographical latitude and the magnetic variation of the needle of the compass. This technique was of great importance for the ships of the "Verenigde Oost-Indische Compagnie" (VOC, United East-Indian Company), which has built up a monopoly position in the trade between the (far) east and Western-Europe. In de period 1605-1608 the lessons in the numerous sciences (algebra, geography, astronomy, bookkeeping, physics, etc.) given by Stevin to prince Maurice were collected and published as "Wisconstige Gedachtenissen" (Mathematical Memoirs). Stevin's last publication, dated from 1617, is a double book: in "Castrametatio, dat is legermeting" [19] (Castrametatio, That is Camp-measurement) he describes the establishment and the furnishing of a well-organized military camp; in "Nieuwe Maniere van Stercktebou door Spilsluysen", (New methods of fortification by spindle-sluices) he describes the use of this special sluices in the defensive works, principally to keep the moats of a desirable depth.

Besides the well-known aspects of Stevin's work, nowadays the less publicised contributions receive an increasing appreciation. In "De Spiegheling der Singconst" [20] (Theory of the art of singing (music)), a manuscript, recovered in 1884 by Bierens de Haan, Stevin was the first to give a correct theory of the division of the octave into twelve equal intervals. In the field of perspective, treated in "Van de beghinselen der Spiegelschaeuwen" (On the principles of mirror images), and "Van de Deursichtighe" (On the transparency) both parts of "Wisconstige Gedachtenissen" Stevin was the first to build on the pioneering work of Guidobaldo del Monte; he contributed fundamental and new theorems regarding projections, which are found under Stevin's name in mathematical works of prominent mathematicians. The influence of Stevin’s concepts in the field of architecture, home building and town-planning receive considerable attention. We find Stevin's ideas in "de Huysoirdening" (Planning of the house) and "Stedenoirdening" (town-planning) included in the "Materiae Politicae, Burgherlicke Stoffen" [21] (Dissertations on political and civil affairs, 1649), published by Stevin's son Hendrik. This material is only a small part of a project for a more elaborated book, planned by Stevin, "Huysbou" (Building of houses), which was never published. Parts of the hand-written manuscript of this "huysbou" were partially reproduced in the journal of Isaac Beeckman [22] and were recently discovered in the Rijksarchief (State Archive) of the province Zeeland (the Netherlands); they show the importance of it for the history of the technique of civil architecture in Stevin's time.

The majority of Stevin's works were published in his mother tongue, the Dutch language. Stevin's goal was to bring science and technology also to non-academic people having no knowledge of Latin, but possessing a certain understanding of science. In the introduction of "De Thiende" he gives the categories of people for which he wrote that pamphlet: stargazers,

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[18] Stevin, S., *De Havenvinding*, Tot Leyden, In de druckerye van Plantiin, By Christoffel van Ravelienghien, Gesworen drucker der Universiteyt tot Leyden, 1599.

[19] Stevin, S., *Castrametatio, Dat is Legermeting* en *Nieuwe Manieren van Sterctebou, door Spilsluysen, Beschreven door* Symon Stevin *van Brugghe*, Tot Rotterdam, By Jan van Waesberghe, in de Fame, Anno 1617.

[20] Bierens de Haan, D. (ed.), *“Vande Spiegeling der Singconst”en “Van de Molens”*, Deux traités inédits par Dr. D. Bierens – De Haan, Amsterdam, 1884.

[21] Stevin, H., *Materiae Politicae, Burgherlicke Stoffen. Vervanghende Ghedachtenissen der Oeffeninghen des Doorluchtichsten Hoogstghebooren Heere Maurits by Gods Genade Prince van Oraengie, Ec. Ho: Ghedachtenisse. Beschreven duer zal.* Simon Stevin van Brugghe, desselfs Heere Princen Superindentant van de Finance &c. En uyt sijn naghelate Hantschriften bij een ghestelt duer Sijn Soon Hendrick Stevin, Ambachtsheere van Alphen, Tot Leyden, Ter Druckerije van Iustus Livius, tegen over d’ Academie, 1649.

[22] *Journal tenu par Isaac Beeckman* de 1604 à 1634 publié avec une introduction et des notes par C. de Waard (Den Haag 1942).

surveyors, carpet-makers, wine-gaugers, mint-masters and all kind of merchants. He extensively exposed his ideas about the Dutch language in his "Uytspraeck van de Weerdicheyt der Duytsche Tael" (Enunciation about the dignity of the Dutch language), written as an introduction to "De Weeghconst". For Stevin the "Nederduyts" was a pre-eminently language to express ideas, especially scientific thoughts, because of its short words and the possibility of word combinations. Stevin's great merit has been that he has enriched the Dutch language by the introduction of new words or combinations of known words as translations of their Latin counterparts. A typical example is the Dutch word for mathematics, "wiskunde" derived from "wisconst".

2. Stevin's writings on the art of war.

Stevin's military works were not all published in his lifetime. The three treatises on military science, published by him-self in book-form are the already mentioned *"De Sterctenbouw, Castrametatio, Dat is Legermeting"* and "*Nieuwe Maniere van Sterctebou door Spilsluysen".* At the moment that Stevin passed away, in the beginning of 1620, he left behind for his widow a pile of unfinished manuscripts. The scholar Isaac Beeckman, who has visited the remarried widow in 1624 several times, made an inventory of Stevin's work and copied part of it. He noted down in his famous journal a list of 28 titles and made several extracts of items which were devoted to different military subjects, with the following titles [23]: *Van de Spabijlhouw* (About the Spabijlhouw = Spade-axe-pick), *Van de geduerighe verlegginghe des crychsvolckx,* (About the continual displacement of troops), *Van de weerdicheden der cryghsampten* (About the worthiness of the Army-Duties), *Oorden der verkiesinge* (Order of selection), *Calis int groot afgebeelt* (Calais depicted in detail), *Chryghssaken* (Miltary matters), *Teghen verdruckingen* (Against reprisals), *Veltslachoordeningh* (Battle-array), *Pyckschansinghe* (Pike redoubts), *Chryghskonst, seer veel daarvan* (The art of war, very much of it), *Verscheyden Chryghstochten, dadelick van hem gesien ende geordineert* (Various campaigns, observed on the spot and controlled as to their order). It seems that those texts were not yet suitable in 1608 to be published in "Wisconstige Gedachtenissen", where some military tracts were treated. However these manuscripts seemed to be more than some idle notes. According to Stevin's own statement [24] this manuscript had not been entirely finished in the year 1608, but that it was to have developed into an extensive work is shown by its large number of subjects and the space they occupy. All these subjects have been included by Beeckman in his journal under the title or collective name: *Vijfde deel der ghemeynghde stoffen. Van de Crijchconst.* Hendrick Stevin published a number of his father's papers concerning military arts in his "Materiae Politicae, Burgherlicke Stoffen". What he presents is not completely in accordance with the survey of the contents found in Beeckman's journal and the contents of manuscripts discussed by de Waard [25]. Schukking [26] even expressed some criticism about the way Hendrick has published his father's valuable military treatises, by agreeing with the disapproval mentioned by de Waard. He formulated his comments as follows [27]:

- Hendrik Stevin wanted to render his own book more readable by merely inserting from the *Conduct of War* matters that could be understood without the practice of mathematics; yet he went too far in this, omitting not only all the drawings, but even very often the calculations as well!

[23] See reference 22, p. 291.

[24] "The cause why they have not been inserted according to the contents of the afore-mentioned arguments, is that they had not been entirely perfected, when the printer did not want to keep any longer what had already printed for such a length of time and kept by him at his detriment; so that I now have the intention to have the above-mentioned remaining part published in due time" (p. 107 at the end of the *Vyfde Stuck der Wisconstige Gedachtenissen),*

[25] see reference 22.

[26] Schukking, W.H., in *The Principle Works of Simon Stevin* (1955-1966), IV

[27] see reference 26, p. 11.

- He has been deliberately incomplete in his description of the arrays of battles, as in this instance he referred [28] to his father's *Crychconst*, at the time still to be published, which however never appeared in print; thus we find with him a great lack of detail in this very important part of army tactics, which consequently has been more amply recorded by Beeckman in his annotations.
- Hendrick has very often inserted in his father's texts personal remarks (it is true under the headings *H.S.*); (…)
- In the very arbitrary classification of chapter VIII: *About the theory of war* of his book, into 17 chapters, he has unnecessarily deviated from the original framework and has caused much trouble to an expert compiler such as Brialmont, who erroneously thought to have discovered Stevin's complete *Théorie de l'art de la guerre.*

To finalize this discussion about the manuscripts on war matters we can refer to the contribution of Van den Heuvel [29], where the still existing manuscripts are described in detail. In volume IV of the Principal Works Works of Simon Stevin, Schukking discusses under the title *Vant belegheren der Steden en Sterckten* (Of besieging towns and fortresses) the contents of many of these manuscripts with many details.

Figure 5: The "spabijlhou", Brussel, Koninklijke Bibliotheek van België, Kostbare Werken, VH 28529A. See also figure 4.9 in "Wonder en is gheen wonder".

Caption: During the siege of towns tunnels are dug under the walls. Stevin suggested for this labour a handy equipment, the so-called "spabijlhou" (spade-axe-pick).

3. The "nederduytsche Mathematicque": in summer time in the field, in winter time inside.

The foundation of the University of Leiden in 1575 must be seen in the war of the Protestant northern part of the Low Countries against the Spanish troops in the South. In the request for the foundation made by William the Silent (Willem de Zwijger) the University is called the bastion for the protection of the whole country. Some professors, such as Justus Lipsius and Scaliger wrote essays about military arts. The education was rather theoretical, with emphasis on the "artes militares" of the antiquity, and not at all practically oriented. Moreover the courses were given in Latin. The war with Spain needed practically trained engineers, who were able to fortify towns very rapidly during the many campaigns. To foresee in this demand Prince Maurice requested Stevin to draw up a program by which engineers could be educated in the Dutch language, the so-called *Duytsche Mathematicque.* Although this education did not have an academic character, it could be seen as part of the university activities. One can read in the resolutions of the curators of the university of January 10ty 1600 [30]:

Sijne Excellentie heeft tot dienst van den lande ende bevorderinge der geenre, die hun tot oeffeninge van het ingenieurscap sullen begeven, orbaer verstaen ***seeckere ordre*** *gevolcht te worden in de leeringe, die men daer aff in de Academie tot Leyden doen sal.*

It was the intention of the founders of the school that the students became as quickly as possible full engineers:

[28] *Materiae Politiciae*, pp. 261,266.
[29] Van den Heuvel, Ch., *De Crychconst* en de *Duytsche Mathematique*, in "Simon Stevin 1548-1620, De Geboorte van de nieuwe wetenschap, (Brepols Publishers, Turnhout 2004), 103-115.
[30] Charles Van den Heuvel (see reference 29) reports that there still exists an original print of the resolution. Parts of the text can be found on the website www.xs4all.nl/~adcs/stevin/varia/index.html.

*Hyer toe sal men leeren die **arithmeticque** oft het tellen ende het **landtmeten** maer alleenlyck van elck soe veel, als tottet dadelyck gemeene ingenieurscap nodich is. Die soe verre gecomen sijn, hebben se alsdan lust die diepsinnige dingen grondelycker t'ondersoucken dat sullen sy mogen doen.*

One expects from the students following the courses that they have some mathematical background and the way the different aspects of mathematics are taught is of importance. In first instance one has to learn the different mathematical operations (addition, subtraction, multiplication, division, extraction of roots) on integers, on fractions and decimal fractions and the rule of three or the invention of the fourth proportional of quantities, by which one solves quadratic equations. There were enough textbooks available on these matters at that time [31]. This knowledge of arithmetic was enough for this kind of engineers. Next topic was geometry and in particular the land surveying. The main topics in that field were:

- *"het **inhoudt vant plat**" (oppervlakte) te vinden door verdeling in driehoeken,*[32]
- *"het meten opt papyer van dijcken, wallen ende **eerdewercken**, te weten hoe veel schachten of voeten den voergestelde wal ofte hoop eerden in heeft"* [33]*.*

Once this theoretical knowledge was instructed the students has to exercise on the field:

*deur 't cleyn verstaende, watter int groot moet gedaen sijn, soe sal men comen totte datelycke landtmetinge int velt, hun wijsende hoe men in plaets van regel, passer ende winckelhaeck op papier, ander **gereedtscap opt velt** gebruyct*

The purpose of this field work is to become familiar with other instruments than the compass, the ruler and the try square, which they have used during their activities on paper. After this fieldwork the students have to learn to draw on paper what they have measured on the field and conversely they must be taught to measure out by means of beacons on the field what is given as a sketch on a figure [34].
After all these preliminary instructions the students were guided to the main activities of an engineer:

*sullen bequaem sijn om totte **fortificatie** of sterckbouwinge te comen, waertoe bereyt sullen worden houtten of eerden botsen van schantsen ende bolwercken*

i.e. the construction of fortifications. The students have to construct models in wood or clay of entrenchments and bastions and they must learn the typical terminology connected to the building of fortresses. Once arrived at this point they can be used in the practical construction of fortifications. In winter time they can ~~be~~ go on with further studies as one can read in the text of the resolution:

*Dus verre gecomen sijnde sullen mogen **in de somer trecken nae tleger** of ter plaetsen daer stercten gebouwt werden, twelck den geenen best gelegen sal sijn, die als soldaten in dienst wesende, dan te velde moeten comen*

*[...] sullen henlyen, die willen, **des winters** tot Leyden mogen oeffenen als voeren geseit is, in **diepsinniger stoffen***

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[31] As examples of available textbooks we can mention *Arithmetica* of Claes Pietersz. (Nicolaus Petri) and of Gielis vanden Hoecke, and Stevin's own *De Thiende*.

[32] The determination of surface area by means of a technique of subdivision in triangles.

[33] The measurements on paper of the quantity of earth present in banks, embankments, etc.

[34] Also for these items the students could lent on textbooks, for example leerboek: *Practijck des lantmetens* of Johan Sems and Jan Pietersz Dou and later on they could use parts of Stevin's *Meetdaet*.

The text of the Prince, inspired by Stevin, concerning the start of these studies is finalized with a sentence in which all the participants are requested to swear that no information will be transferred to the enemy:

Men verstaet oeck dat alle die geene, die tottet leeren deser const van ingenieurscap toegelaten worden, eerst sullen beloven ende zweeren ***aen den viandt*** *deser landen daermede* ***geenen dienst*** *te doen.*

4. Stevin's *De Sterctenbouwing* (The Art of Fortification).

Figure 6: Front page of "De Sterctenbouwing".

Caption: In "De Sterctenbouwing" Stevin describes how fortifications can be constructed in the Netherlands.

Stevin's Art of Fortification of 1594 is to be regarded as a textbook. He teaches not only the theory but also the practice of building fortresses, just as many of his Italian and French contemporaries. He, however, surpasses them in clarity. Stevin understood that he wrote for simple people and not for learned man. As explained in the Dedication he used the vernacular [35]:

De sterckten deses tijts, welckemen sterckten noemen mach, te weten die door wisconstich beleyt, met sichtstralen {Mathematicam operationem radiis visualibus.} opt meeste voordeel gheteyckent worden, sijn inde Italiaensche ende Françoische spraken soo overvloedelick beschreven, dat ymant dencken mocht daer af ghenouch ghedaen te wesen: Doch twee merckelicke redenen hebben my beweeght derghelijcke oock in onse tael te doen. Ten eersten, om daer mede te gherieven veel Nederduytschen in die spraken onervaren, als Kriegsluyden, Boumeesters {Architectis.}, ende ander tot wetenschap van dien belusticht, waer uijt volghen can, niet alleen vernoughinghe van soodanighe besonder persoonen, maer oock daden {Effecta.} streckende tot dienst des ghemeene Landts. Ten tweeden, om dat onse tale het selve (ghelijc oock alle stof {Materiam.} daer swaricheyt in gheleghen is) veel beter uijtbeelden, ende grontlicker verclaren can als eenighe ander [36].

The book is dedicated to

D E N E D E L E N

Ernstesten, Hoochgheleerden

Ioncker H E N D R I C K *van* B R I E N E N,

[35] The texts of the English translation are taken form the Principal Works of Stevin (see reference 26).

[36] The fortresses of the present time that deserve to be called fortresses, to wit, those which are drawn most advantageously by mathematical methods, with auxiliary lines, have been described so amply in the Italian and French languages that one might think that enough has been done in this respect. But two notable reasons have been induced me to do the same also in our language. In the first place in order to oblige therewith many Dutch people who are not conversant with those languages, such as soldiers, architects, and others desirous of knowledge of this science, which may result only in the satisfaction of such special persons, but also in actions tending to serve the common country. Secondly, because our language is capable of expressing it (as well as any subject matter of a difficult kind) much better and explaining it more thoroughly than any other.

ghedeputeerde van wegen des Vorstendoms van
Gelderlant, ter vergaderinghe vande Heeren
Generale Staten, veel ghelucx.

Stevin was well acquainted with this deputy of the States General and was on friendly terms with him. Joncker Hendrick van Brienen, born ca. 1540 and deceased 1620, was - besides being burgomaster of Harderwijk- , where he lived already since 1563, a member of the nobility of the Veluwe, councillor of the Court of Gelderland and for many years deputy for Gelderland in the States General and in the Council of State.

Stevin did his best to give his book a methodical lay-out, which is even announced in the Dedication, in the Argument and in the associated table. This lay-out appears to have been worked out in seven chapters:

Chapter 1: Enumeration and explanation of 21 "definitions", i.e. the principal technical terms for the art of fortification of his time.

Chapter 2-4: Explanation of the construction and building, in theory and practice, of regular fortresses, with the bastioned hexagon as the easiest example and subsequently of other regular polygons, i.e. the 5-, 7-, 8-, 9- and 10-angle.

Chapter 5: The main principles underlying the object of building fortresses.

Chapter 6-7: A large number of considerations, called *verschillen* (differences), prevailing at the time among builders of fortresses on important problems in their art of building regular and irregular fortresses, respectively.

Great fortress-engineers, such as Brialmont and Wauwermans speak highly of Stevin's military work. It is also worthwhile to mention that Stevin has consulted the work of many other authors on fortification. He also has borrowed a few things from their work: in Stevin's work itself one finds quotations from the military writings of Tartaglia (1546), Macchiavelli (1521), de Pasino (1579), Speckle (1589) and some other less widely known authors. The fact that these and similar works were available to Stevin may also appear from the Catalogue of Prince Maurice's library.

Stevin's work on fortresses was translated in different languages. The English translation of 1604, in manuscript form at the library of Trinity College of Cambridge [37], has never been printed. The question why an English translation was so soon available is not difficult to answer. For in 1604, the year which the manuscript bears, there were still a fair number of English troops in the service of the Republic and possibly one of the engineers of that army can have taken the initiative for the translation, after returning home. The book has also been translated into French and German. The French translation of 1634 by Albert Girard, occurring in the *Oeuvres Mathématiques* [38] is presumably the only one, but is in any case the best known one. The German translator, Gothardum Arthus von Dantzig anticipated the French: as early as 1608 the first edition of *Festung-Bawung* was published at "Frankfort am Mayn"; an "improved" but probably identical reprint, also as regards the dedication, appeared in 1623.

[37] The existence of this manuscript is mentioned by Schukking in volume IV of The principal works of Simon Stevin .

[38] Les Oeuvres Mathematiques de Simon Stevin de Bruges. Ou sont insérées les Memoires Mathematiques Esquelles s'est exercé le Tres-Haut & Tres-illustre Prince Maurits de Nassau,…, Le tout reveu, corrigé, & augmenté par ALBERT GIRARD Samielois, Mathematicien, (1634) edited by Bonaventure and Abraham Elzevier in Leiden.

5. Stevin, as military adviser to Prince Maurice and the States General.

We like to describe here in particular the role of Stevin in the projects for the improvement of the fortifications at Harderwijk. During the 80 Years' War the town of Harderwijk was particularly important, because it could make it difficult for the enemy, when evading the Veluwe, to cross the Zuiderzee and to land in North Holland. For that purpose its fortifications needed considerable improvements. F.A. Hoefer in volume XXVII (1924) of the "Bijdragen en mededeelingen der Vereniging Gelre"(Contributions and Informations of the Gelre Society) and also Schukking (see reference 26) described the papers concerning the improvements of these fortifications, kept in old Harderwijk archives, where documentary evidence of Stevin's share in the various projects are given. It is worthwhile to discuss these participations of Stevin in some detail. The original texts and the English translations are taken from Schukking (reference 26).

a. Record no. 592: Letter of instruction by Prince Maurice dated December 16, 1598:

"Zijne Ex.tie lastgevende Symon Stevin, hem te transporteren near Hardwerwyck, ende aldaer de fortificactien te besichtighen omme Zijne Ex.tie daernaer daervan rapport te doen, Versouckt daeromme den Magistraet der selve Stede van Harderwyck, hem daerinne alle behoorlicke assistentie te verthoonen, ten eynde hy zoo haest mogelick mach wedercommen, Actum Arnhem den 16en December 1598" [39], was signed Maurice de Nassau.

b. Record no 276: From the accounts of the Bailiff of Harderwijk, 1598/99:

"Den 16en Decembris betaelt aen Mr. Stevijn vund Mr. Davidt (van Orliens) ingenieurs vant affsteecken vund pourtraictheren vander Stadt wercken volgende de resoluti vande Schepenen 82 gulden 2 stuvers…" [40]

c. Record no 592, see also Hoefer suppl. VI: Resolution of the Prince on January 10, 1599.

"Syn Excellentie heefft opt schriftelyck versoeck van de Gecommitteerde Raden der Heren Staten van Hollant gecommittiert sijn matematicum Stevyn ende Davidt van Orliens, ingenieurs van den lande, om henluden te transportiren naer de stadt van Harderwyck, deselve in hare forteressen te besichtigen ende in hare hoeckken, lengden, breeden, hoechden ende diepten pertinenteliken aff te treckken, maeckende daervan caerte naer de juiste mate, ende vervolgens t'aviseren op de forsieninghe, genochsam sijnde tot versekerynghe van de Zuyrzee. Ende naer gehoerden rapporte heefft deselve Siin Excellentie by rype deliberaty de vornoembde fortificaty van Harderwyck bevonden oerbaer ende nodich ende dat naer uytwysen van dyt tegenwoerdig plan volgende de rhode ende geele linien, waermede de niewe fortificatie beteekent wort.
Gegeven in 's-Gravenhage den 10 Januarii 1599."[41], was signed Maurice de Nassau.

[39] His Exellency orders Symon Stevin to travel to Harderwyck and to inspect the fortifications in order to deliver a report to His Excellency after inspection, therefore Requests the Magistrate of this town of Harderwyck, to render him every assistance, so that he may return soonest possible, Actum Arnhem Dec. 16, 1598.

[40] Paid on December 16th to Mr. Stevijn and Mr. Davidt (van Orliens) engineers for the marking off and portrayal of the fortifications of the town according to the resolution of the Aldermen 82 guilders and 2 pennies…

[41] Upon a written request by the Delegate Councils of the members of the States of Holland His Excellency has delegated his mathematician Stevyn and Davidt van Orliens, engineers of state, to travel to the town of Harderwyck, in order to inspect its fortifications and to mark off their exact angles, lengths, widths, heights and depths, to draw up a ground-plan according to these exact measurements and then to give advice whether sufficient provisions have been made for the protection of the Zuyder Zee. And after the report had been delivered, His Excellency, after mature deliberation, considered the afore-mentioned fortification of Harderwyck to be appropriate and necessary and that upon the indications of the present design, following the red and yellow lines, by which the new fortifications marked. Issued at The Hague, January 10, 1599.

d. Record no 597, see also Hoefer, suppl VII: Estimate for the construction of the Western bastion on sea

"Besteck van de stadt, gedain by Mr. Stevyn und Mr. David, ingenieurs. Conditien ende besteck, waernae miin Heeren de Staten-Generael ende door den expressen last unnd beveel van Siin Excellentie aen de stadt van Harderwyck besteden willen te maecken eenen muyr op westzyde van de bollewerck, datt men leggen will voor het oude blockhuis in manieren als volgt."[42]

In what follows a description of the wall to be erected is given. It should have a length of 40 rods and would cost fl. 10290. From the resolutions of the States General over the years 1598-1599 it becomes clear that this College passed on April 5th 1599 the resolution to adopt the project for a partial improvement by Adriaan Anthonisz., who had already surveyed the fortifications during the years 1586-1588, 1590 and 1597 and who has designed various improvements.

It is well-known that Stevin was involved in the advise concerning the construction of fortifications in Vlissingen (Flushing), Batavia (Djakarta, present Indonesia) and Den Haag[43]. The construction of the fortress in Batavia will be considered here in some detail.

Batavia was a clear cut copy of the Dutch town at that time with canals, drawbridges, canal houses, step-gables, a church, church bell-ringing and streets paved with cobble stones. It passed through two stages, namely the settlement of the old town and the phase of suburbanization. During the first stage the town was developed according to existing ideas on the "ideal" city. During the second stage the Dutch turned away from the old town towards the new town of Weltevreden, developed according to the notions of the acculturated elite. Afterwards the town got its Indian character.

Batavia was founded by Jan Pieterszoon Coen, who had the town laid out after a map made by Simon Stevin, who was also a town planner. According to Brommer and De Vries[44] this can be deduced from a letter from the Heeren XVII who asked Stevin to design a fort and town for them. The town was shaped around a central part, a main street that connected the castle with the town-hall and left room for beautiful vistas from the town centre in between. Batavia got a rectangular system of canals. This system until today causes tremendous problems for the Indonesian capital, both by its restricted capacity and the related floods, and by the unhygienic circumstances. Stevin's part in the general conception of the New Castle of Batavia, the building of which Coen decided on July 2nd 1619, is shown from Coen's correspondence[45] to the Heeren XVII. By a letter, dated April 10th 1618, this board of Trustees, in consultation with Prince Maurice, instructed Coen to built a square bastioned fortress.

The instruction ran as follows:

[42] Devide of the town, made by Mr. Stevin and Mr. David, engineers. Terms and specifications, according to which the Lords of the States General by special order and command of His Excellency to the town of Harderwyck invite tenders for the erection of a wall on the West-side of the bastion, to be erected before the old blockhouse in the following manner.

[43] For a lot of details see reference 26.

[44] Brommer, B. and de Vries, D. , Historische plattegronden van Nederlandse steden, deel 4 Batavia. Alphen aan den Rijn: Canaletto. (1992).

[45] Colenbrander, H.T., *Jan Pietersz. Coen, Bescheiden omtrent zijn bedrijf in Indië,* 7 volumes, (The Hague, 1919-1953). The letters quoted occur in Vol. I, pp. 491, 503 and in Vol. IV, p.402.

"By naerder conferentie met syne princelijcke Excellentie… soo is voor best gevonden datter maer één quarré, gelijck als hetgene van het casteel van Gulick, soude gemaeckt warden, soo groot als uwelieden ende raden sullen noodich achten, omme daerinne, behalven de noodige packhuysen ende magasynen, 6 ofte 800 man te mogen logeren, volgens het project by den ingenieur van sijn Excellentie Simon Stevijn gestelt. Hij heeft daarby oock een ontwerp van eene stadt gemaeckt…doch wij achten dat het vooreerst niet en sal van nooden wesen daeraen noch te komen, maer dat het casteel alleene sufficant sal wesen(…)" [46]

In 1619 the construction of the new fortress in Batavia was started.

6. Stevin and the introduction of Dutch words for parts of fortifications.

In the literature about fortifications of the sixteenth century, foreign - mostly Italian and French - words were used. Stevin is a genius when he introduces new Dutch terms in his books. The study of the contribution of new words by Stevin to the Dutch language cannot be discussed here. We can refer to Devreese and Vanden Berghe[47], chapter 8, and Van der Wal[48] for a more detailed discussion on that matter. It is difficult to judge if the newly introduced words can be considered as neologisms of not. In our opinion Stevin, more often than not, started from words - already in use with artisans- which he sometimes gave a new meaning. It is very instructive to introduce here a number of his definitions, by which he describes some of the parts present on the 8th form in his book on page 26 (see figure 7).

Figure 7: Page 26 of "De Sterctenbouwing", Brussel, Koninklijke Bibliotheek van België, Kostbare Werken, II 16691 A.

Caption: In "De Sterctenbouwing" Stevin describes in the so-called 8th form the different parts of the fortresses.

I^e B E P A L I N G .

"BO L W E R C K E N {*Ital. Belouardo. Franç. Boulevart.*} sijn de uijtstekende hoofden der sterckten, … ofte inde 8e form de twee bolwercken A, B. Angaende den oirspronck des naems {*Etymologiam.*}, die schijnt dese: Ghelijck het reetschap {*Instrumentum.*} dat de uijren oirdentlick beteyckent, sijn naem heeft van werck ende uijr, als oftmen wilde segghen een werck dat de uijren onderscheyt, alsoo crijcht dit hooft den naem bolwerck, van weghen werck en bolle, twelck soo veel te segghen is, als werck om te wederstaen de bollen of clooten des viants die daer op gheschoten worden, oock om van daer bollen na den viant te schieten. De Italianen dese Duytsche naem navolghende, segghen in ghebroken tael *baloardo*, ettelicke *belouardo*, ander *balluardo*, t'welck eenighe bepalende {*Definientes Als Iacomo Castriotto libr.* I *cap.* 9.}, meijnen t'selve te commen van *bellum*, dat crijch beteeckent, ende *guarda* dat is bewaernis, als oft den sin waer bewaernis teghen den crijch: Maer soo hun den rechten Duytschen oirspronck bekent waer, ick vermoede dat sijt soo niet

[46] Upon further consult with his princely Excellence…it has been considered best that only one square is to be built, like the one of the castle of Juliers, its dimensions to be determined by Your Honours and the Board of Trustees as will required to provide accommodation (apart from the necessary ware-houses and stores) for 6 or 800 men, according to the project made by his Excellency's engineer Simon Stevijn. Together with this project he has also made a plan for a town… but we are of the opinion that for the time being this need not to be considered and that the castle as it will suffice(…).

[47] Devreese, J.T. and Vanden Berghe, G. *'Wonder en is gheen wonder, De geniale wereld van Simon Stevin, 1548-1620,* Davidsfonds Leuven (2003).

[48] Van der Wal, M.J., *Simon Stevin, taalbeschouwer en taalgebruiker,* in Simon Stevin 1548-1620, De geboorte van de nieuwe wetenschap, Brepols Publishers Turnhout (2004).

bepalen en souden, te meer dat de Françoisen het Duytsch noch naerder commende, dat *boulevart* heeten." [49]

2e B E P A L I N G .

"W A L L E N {*Ital. Ripari. Franç. Rempart.*} sijn de eerste dammen tusschen twee bolwercken ligghende, …C inde 8e form. Ende hoe wel men alle eerde dammen of hooghden int ghemeen wallen mach heeten, doch wort dese naem hier wat eyghentlicker ghenomen." [50]

3e B E P A L I N G .

" C A D E N sijn de buytecanten des grachts, …Inde 8e form D." [51]

4e B E P A L I N G .

" G R O O T E gracht {*Grand foßé.*} noemtmen t'gene tusschen bolwercken en wallen ter eender, ende de caden ter ander sijde begrepen is." [52]

5e B E P A L I N G .

"M I D D E L G R A C H T {*Ital. Fossetta oock Conetta. Franç. Contrefoßé.*} is die ontrent het middel der groote gracht light:… Inde achtste form E." [53]

6e B E P A L I N G .

"L E E G H E walganck {*Ital. Terraglio, Terra pieno, Strada. Franç. Terreplain, Chemin, Allée. Hoochduyts Lauff.*} is de wech die opden ondersten wal light; hooghe walganck die opden bovensten light. …ende F inde 8e form bedien den hooghen walganck." [54]

7e B E P A L I N G .

"B O R S T W E E R {*Parapetto. Gordinen.*} is het ghene daermen achter beschut can staen tot de borst toe, als inde Ie form *no, pq*, …borstweeren des hooghen ende leeghen wals, welcke door de ghebruijck oock Gordinen ghenoemt worden, om datmen daer achter schuylt als achter een gordine. Dese naem gordine comt van (soot de Duytsche Letterconst {*Grammatica.*} uijtleght) *gort* ende *in*, als oftmen wilde segghen een dinck datmen ingort:

[49] Bastions or bulwarks are the projecting parts of fortresses, … or in Figure 8 the two bastions A, B. Concerning the derivation of the same "bullwork", it seems to be this: just as firework has its derivation from fire and work, so bulwark or bullwork derives from bull and work, which means a work to resist the bullets or shot that the enemy shoots against it, or thence to shoot bullets to the enemy. The Italians, following the Dutch word in broken language, call it baloardo, some belouardo and others balluardo, which would seem to be derived from bellum, which signifies war, and guarda, that is defence, as if it were a defence against the war. But if they correctly understood the Dutch derivation, I think they would not define it like this, the more because the French, following the Dutch more closely, call it boulevard.

[50] Walls or ramparts are the dams or banks of earth that stretch between two bastions …C in Figure 8. And although we may call all earthen dams or heights commonly walls, yet this name is more proper here.

[51] Bank is the outside of the ditch, …D in Figure 8.

[52] Large ditch we call that which is shut in between the bastions and the walls on the one hand and the bank or outside of the ditch, on the other.

[53] Middle ditch (cunette) is that which lies about the centre of the large ditch, as …E in Figure 8.

[54] Lower wallway is the way that lies on the lower wall; higher wallway is the one that lies on the uppermost wall; …F in Figure 8 indicate the higher wallway.

welcken Duytschen oirspronck {*Etymologiam.*} de Italianen inde sterckten oock navolghende, segghen *cortina* {*Ital. Cortina, eenighe Coltrina.*}, de Françoisen *courtine*." [55]

It is clear from the above examples of definitions that Stevin tries to explain, in an etymological way, some of the technical words used in his descriptions. In the spirit of his time he puts forward the Dutch language as one of the basic European languages, which has been imitated by other European languages. His suggestions on this subject are not always realistic. As remarked by Schukking it is doubtfull that the Italians and French should have imitated the Dutch in the word "cortina". Castriotto and Maggi speak already about the "cortina" in many places in their book *Della fortificatione delle cite* (Venice 1564 and 1584).

7. Stevin's Castrametatio, the marking out of army camps

Figure 8: Front page of "Castrametatio".

Caption: In "Castrametatio, Dat is Legermeting Stevin compiles his knowledge and experience in the domain of marking out of army camps

The book *Castrametatio, Dat is Legermeting*, published in 1617, at the end of Stevin's career, can be seen as a compilation of the great knowledge and experience at his disposal in the domain of marking out of army camps. Stevin was officially sworn-in in the States Army on January 31st 1604 [56], but it is well-known that he had served in this army from the mid-90's. From a notification by Prince Maurice to the Council of State in 1603[57] it is known that Stevin, since around 1593, has been employed in the army as an "affteeckener der Quartieren" (a surveyor of the Quarters), but is was only in 1604 that he received an official appointment as a "Quarter-master to mark out the quarters". Little is known however of Stevin's activities in the field during the period 1593-1604. His name does not appear anywhere in the works on Prince Maurice's famous sieges, but we can take for certain that he has been a witness to many of these sieges. In Stevin's own writings we can read that he knew details of the sieges of Hulst (1591), Grol (1597), St. Andries (1600) and Ostend (1601-1604).[58] One can find a description of the task of a quarter master in "*Ruich Ontwerp van Krychs-Saken ende t'gevolch van dien. Gelyck het hedensdaeges by Haere Excellentie Prins Mauritius van Orangien Grave van Nassau, in die vereenichde Nederlantsche Provintien gebruickt wort",* a manuscript - following Schukking - present in the Archives of the General Staff, History of War Department. Ten Raa and De Bas [59] mentioned that this manuscript probably has been compiled by Stevin himself. The following excerpt from this manuscript, which has presumably been compiled about 1610 and which assigns Stevin to the group of "*Principaele Crijchs-Officieren die int Leger gebruickt worden",* briefly explains the tasks of the *Legermeter:*

"Den Quartiermeester Generael Simon Stevijn geeft elcke troupen syn Quartier omme te logieren, ende commandiert over alle andere, soo wel generaele als particuliere Quartier-

[55] Parapet is that behind which men may stand protected breast-high, …the parapets of the lower and higher walls, which are according to custom also called curtains, because men can hide themselves behind it like behind a curtain. This name curtain (according to Dutch etymology calles gordijn) is derived from gort and in, as if one would say: a thing that is girded in, from which the Italians in their fortresses call it cortina and the French courtine.

[56] See page 249 of reference 26.

[57] See Dijksterhuis, E.J., *Simon Stevin*, (Nijhoff, 's Gravenhage, 1943) , p. 10.

[58] See Reference 26, p. 12.

[59] Ten Raa, F.J.G. and De Bas, F.,*Het Staatsche Leger*, vol II (Breda, 1913) , (1588-1609), p.38; Vol. III (Breda 1915), (1609-1625),pp. 14 and 18.

Meesters soo te peerde, als te voete; geeft den particulier Quartiermeesters van den Regimenten die ordre van quartieren, end die plaetse, waer hun regimenten sullen coomen te liggen, daeromme alle quartiermeesters bij den Quartiermeester Generael voor aen die eerste troupe moete rijden, omme die plaetsen voor haere Regimenten t'ontfangen sin gagie is ter maent…[60]

Note that the *gagie* (pay), i.e. Stevin's monthly salary, has not been filled in; according to the *Staten van Oorlog* (States of War) of 1607 and following years, Stevin earned in that function 50 guilders. One can find a yearly salary of 600 guilders for Stevin for the year 1604 in the General Ledger of the Nassau Council, a pay which is the third or fourth highest in the long list of yearly incomes of people in the service of the Prince (see also General Introduction).

The lay-out and the internal organization of the army camps or entrenched "quarters", doubtless one of the inventions of Prince Maurice and his cousin Count William Louis of Nassau, after the model of the Romans, was certainly improved by Stevin over the years. The general tenor of Stevin's treatise can be described as follows: it gives a description of the "encampment in the field" as it was effected during Maurice's campaigns. The work is dedicated to the States General and the dedication is worth to be read:

"*Aen de hoochmogende heeren de generale staten der vereenichde Nederlanden.*

Nadien van ouden tijden, en ooc over korte jaren herwaerts, veel en wel vande Leghermeting gheschreven is, als wesende een der voornaemste deelen des Krijchs, daer de voornaemste Amptlien de Leghers van de Romeinen, te weten de Tribuni het bewint afhadden, zoo heeft syn Vorstelicke Ghenade die ernstelic doorlesen, en dat niet allen spieghelingsche wijse, maer boven diende zelve dadelic te wercke ghestelt, daer by voeghende syn eyghen vonden ende oordeninghen na den eysch van de maniere des Krijchs diemen nu ter tijt voert: Alwaer bevonden wort, dat nadien elc in syn quartier (ter plaets ghekomen wesende) terstont bout, om haest bevrijt te zijn tegen reghen, onweer, of heet Sonneschijn, en daerentusschen t' ghebou int gheheel oordentelic moet voortgaen, ooc om het heele Legher haest te moghen omgraven, zoo was het noodich veel Amptlien aen't beleyt van dien hun wel te moeten verstaen, zommighe in 't gheheel, ettelicke inde bezonder deelen, als van regimenten of ander quartieren daer sy de last afhadden, tot welcken eynde aen elc onderrichting ghedaen wiert na den eysch van syn quartier: Maer om zulcke onderrichting noch beter te doen, zoo heeft my de bequemste wegh ghedocht vande stof der Leghermeting dese verklaring te doen: Want hoewel daer af (als voren verhaelt) veel gheschreven is, zoo vereyscht nochtans alfnu dit bezonder ghebruyc syn bezonder onderricht. Ooc heeft my ghedocht myn beroep zulcx te vereysschen, om dattet v Hoochmoghende Heeren belieft heeft my vande Leghermeting den last te gheven, daer af ic de voorgaende jaren inde daet te Velde de oordening en beval van syn Vorstelicke Ghenade gevolcht hebbende na myn vermoghen, zal nu inde spiegheling, voorderlic zijnde totte daet, zoo veel doen als ic kan. Daer me ic ooc te vrymoedelicker voortga, om dat op verleden jaren de grontteeckeninghen der Veltlogieringhen vande Leghers uwer Hoochmoghentheden, begheert zijn geweest niet alleen by leeghe persoonen, maer ooc by groote Vorsten in verre Landen.
Aengaende tghene hier in beter zoude hebben konnen ghedaen zijn, bidde my daer af ontschuldicht te worden, als gebrekende aende volkomen wetenschap, diemen acht gheen mensch te hebben, ende niet aen den goede wille, daer me ic na myn ghering vermoghen bereyt ben tot uwe Hoochmogentheden dienst

[60] The Quartermaster General Simon Stevijn assigns to each body of soldiers their quarters to lodge in, and is in command of all the others, both Quartermasters General and private Quatermasters, mounted as well as on foot; assigns to the private Quartermasters of the various Regiments the respective order of their quarters and the place, where their regiments are to be lodged; that is why all the Quartermasters together with the Quartemaster General have to ride in front of the first body of troops in order to obtain the required space for their respective regiments. He receives a monthly salary of ….

Gheschreven inden HAEGH, den 4 November, 1617
Door uwe Hoochmoghenthden Leghermeter en onderdanighen Dienaer
Symon Stevin" [61]

Following the resolution of the States General dated March 23rd, 1618 "Simon Stevin van Brugge, Legermeter van Hare Ho.Mo." is being granted 200 guilders with regards to the dedication of the two books: *Castrametatio* and *Nieuwe maniere van Stercktebou door Spilsluysen.* In this dedication Stevin clearly mentioned his presence in the field. In figure 9 showing the "Quartier de son Ex[celence] estant en Campaigne " one remarks Stevin's tent in the close neighbourhood of the tent of the Prince.

Figure 9: Figure present in Delft, Koninklijk Nederlands Leger- en Wapenmuseum "Generaal Hoefer" taken from folia [68v.-69r] of "Stevin-manuscript" (see also "Wonder en gheen wonder", figure 4.8)

Caption: Stevin was as quartermaster responsible for the measuring out of encampments. On this ground plan one can see that Stevin's tent is situated in the immediate neighbourhood of the tent of Maurice.

The general tenor of Stevin's treatise has been to give a description of the encampment in the field as it was affected during Maurice's campaigns according to the example set by the Romans yet without following them in too servile. The organization of the various troops and their equipment in the Army of the States General was inspired by the Romans, yet it considerably differed from its model. This difference in organization is paid particular attention to, both in the beginning and at the end of the book. The book is subdivided into four chapters. In the first three of these the author gives in succession:

[61] To their high and mightiness the Lords of the States General of the United Netherlands.

As in olden times and also during recent years there have been ample and excellent writings on the Art of marking out army camps, being one of the principal elements in warfare, of which the principal military officers of the Romans, viz. the Tribuni were in command. Therefore His Princely Grace has elaborately studied these writings, not only theoretically but also by practical application, whilst adding to them his own inventions and methods according to the requirements of the Art of war of our times. Hereby it was found that since everybody (after having reached his destination) starts building his lodgings at once in order to be sheltered as quickly as possible from rain, thunder of fierce sunshine and meanwhile the building of the camp as a whole has to proceed in an orderly manner also with a view to a speedy entrenchment, it was essential that a great many officers had to know their jobs well, particularly so as to the conduct of the work in hand, some with regard to the work in general, a great many others with regard to its various parts, such as the respective regimental or other quarters of which they were in charge and for which purpose every one of them received special instruction according to the requirements of his lodgings. However, in order to improve this instruction, I have thought that the best course to pursue would be to give the subject-matter of the Castrametation the following explanation. For, although (as has been stated before) there has been written a great deal about it, its particular application as such, requires special instruction. Further I have thought that my profession calls for this action, as your High- and Mightiness have been graciously pleased to entrust me with the Castrametatio; and, where in previous years, I have followed in the field the method and instructions of his Princely Grace in practice to the best of my ability, I shall now devote myself to its theory as it is conducive to its practice. I shall therefore boldly pursue my endeavours since in previous years the ground-plans of the encampments in the field of your High- and Mightinesses' armies were not only desired by persons of lower rank but also by great sovereigns in distant countries.
As to all that could have been done better in this writing, I beg to be excused, it being merely attributed to a lack of complete knowledge, that no man can possess, and not in any way to a lack of good will, by which in my humble power I am willing to serve your High- and Mightiness.

Written in the Hague, November 4th 1617, by your High- and Mightinesses' camp-measurer and obedient Servant
Symon Stevin.

- A sketchy outline, together with the necessary explanations and figures, of a Roman army camp (according to Polybius) taken in a general sense, and describing in detail the method of encampment of the States army and their command, the equipment, the arrangement of the so-called market-place and finally the encampment as a whole, taking the one before Gulik (Juliers) in 1610 as an example.
- An outline in the form of seven "lists" about the organization, likewise according to the States Army before Juliers, i.e. of the commanding and other officers, the regiments, the artillery, the war-munitions, the carriages and ships for the various commanders, army units and services.
- The way in which the quadrilateral quarters were drawn on paper, according to the lists showing the strength of the forces, etc. then marked out on the camp-site by the camp-measurer and his assistants, the measuring of the camp-streets within these quarters for each regiment and the space required for the army-huts in the respective streets the alarm-posts and finally a series of regulations for the upkeep of the camp in its various parts.

The fourth chapter is a combination of three different subjects. The first section which deals with the deviations from the Roman way of encampment contains a continuation and partly a recapitulation of the statement given in the first section of chapter 1, entitled *Vande legering int ghemeen, mette form des Romeynschen Leghers*, (About the encampment in general together with the figure of a Roman Army camp). In both sections Stevin mentions the Polybian army camp as his starting-point; the ground-plan taken from Lipsius' translation of 1585 [62]. In chapter 4, fol 43, Stevin recapitulates the objections against it, which Prince Maurice had experienced in its application and which chiefly consisted in a lack of space for the soldiers of the States Army; further it appeared from experience that camp-sites measuring 2000 feet in length and width on a ground, that has not been undergrowth, hardly ever occur and that in case of a siege one had to adapt it to the local situation the investment demanded. The second section, containing Stevin's proposal for a permanent camp, is kept very concise, presumably because of the fact that its realization would certainly have been very difficult as naturally any army-organization is always liable to change. The third section of chapter 4 brings the reader to another problem: the most suitable organization of the States Army corps (infantry and cavalry). In his investigation of this problem Stevin arrives at the *tienighe verdeeling* (decimal order) and demonstrates this by the army-organization of the Israelites or Hebrews [63]:

Krijchsvolcxverdeeling der Hebreen.

Na 'tschrijven van Iosephus, zoo heft Moyses door den raet van Raquel syn Huysvrouwens Vader, Hooftmannen ghestelt over elcken hoop van dusdanighe menichte.
10000. 1000. 500. 100. 50. 30. 20. 10. [64]

[62] It is known that Prince Maurits has studied the *Militia Romana* of his previous teacher Lipsius with must interest (see for example the letter of Raphelengius to Lipsius (Burmannus, Sylloge Epistolarum I, p. 201): "Militia tua hic omnibus probatur: Principi praecipue, cui, dum in castris contra Dragonium est, unicae deltiae eius lectio, et saepius militum ad eam formam exercitatio".

[63] Stevin has derived this distribution from two sources following Schukking: *Exodus XVIII:* 21 viz. Raguel's advice to Moses: "Moreover thou shalt provide out all the people able men, such as fear God, men of truth, hating covetousness; and place such over them, to be rulers of *thousands*, and rules of *hundreds*, rulers of *tens*" (*King James' Bible)*; and Flavius Josephus, *Jewish Antiquities* III. 70-72, published in 1594 at Leyden by Everardus Bommelius, the same advice: "Follow but my advice on mundane matter, and thou wilt review thy army diligently and divide it into groups of *ten thousand* men, over whom thou wilt appoint selected chiefs, these into *thousands*; next thou wilt proceed to divide these into groups of *five hundred*, and these again into *hundreds* and *fifties*".

[64] Distribution of Soldiers with the Hebrews. According to Josephus' writing, Moses by following the advice of Raquel, his housewife's Father, appointed Chiefs to each body of the following multitudes:
10,000. 1,000. 500. 100. 50. 30. 20. 10.

That is in contrast to the Greeks and the Romans; also the Tartar armies under Tamerlan and Dzengis Khan had adopted this order. However, for lack of data about the Tartar Army camps, he has followed the Castrametation of the Romans, who apparently also in this respect have been influenced by the Greeks.
In concluding the "neo-Roman" army camp of Prince Maurice before Juliers of 1610 is - as an example- known the best of all; its ground-plan figures as a kind of model not only for Stevin, but also for the contemporary architect Samuel Marolois, and is also present in most of the manuscripts dealing with the encampment of the States Army. Later authors have copied figures and text from the Castrametatio. So Stevin's or perhaps better Maurice's Castrametatio has been followed in later days. As regards the campaigns, it is clear that Prince Frederick Henry, who had shared so many of his brother's feats of arms, used during his sieges quite often the classical army camps of Maurice. Brialmont[65] demonstrates that Stevin's work has been the basis of various writings, in which one finds exactly the same fundamental principles. He gives as an instance Marolois' *Sterckten-bouwingh* of 1627, Adam Freitag's *Architectura Militaris* of 1630 and Mannesson Mallet's *Travaux de Mars* of 1671.

8. Nieuwe maniere van Sterctebou door spilsluysen (New manner of fortification by means of pivoted sluice locks)

This book first published in Rotterdam in 1617 has to be situated in the studies of Stevin on hydraulic engineering. From the title it claims to be a work on the art of fortification: in fact it indicates considerable improvements for fortresses situated on the waterfront and provided with wet ditches. In the dedication Stevin clearly explains to "their high mightinesses, the states general of united Netherlands" the reasons why pivoted sluice locks can be used in fortification matters:

"Is kennelic, Hoochmoghende Heeren, dat de Watersteden, gheleghen aen Zeen en groote bevaerlicke Rivieren, op beyde de eynden aen de waterkant kranc zijn, hebbende tot die plaetsen of drooge Grachten, of Beeren, buyten welcke men met leeghe wateren drooch voets aende mueren of wallen kan komen: Maer want door de nieuwe vondt der schuerende Spilsluysen onlancx te voorschijn ghekomen, de krancke plaetsen bequamelic versterct konnen (…) Tis wel zoo, dat eenighe die my vermaent hebben, de zake van Sterctebou te laten uytgaen, daer af een volkomender beschrijving verwachten: Maer my heeft goet ghedocht voor eerst dit ghedeelte daer uyt te trecken, op dattet niet staende onder veel ander stoffen die niet yghelicx gading en zijn, te beter van velen mocht gelesen worden, en voornaemlic van zulcke diens oordeel totte zake ghelt, om het dadelic ghebruyc daer uyt te doen volghen: Tot dien eynde ist ooc, dat ic desen handel uwe Hoochmoghentheden toeeyghen, die ic, hopende dat sy myn goede meyning int goede zullen nemen, wensche voorspoedighe regiering." [66]

[65] Henri Alexis Brialmont, Belgian military engineer (1821-1903).

[66] It is obvious, Your High Mightinesses, that water-side towns on seas and large navigable rivers are vulnerable at both sides on the edge of the water, since they have either dry town-ditches or dams at those places, through which one can approach the wall with dry feet at low-tide. But because by the recent invention of scouring pivoted sluice-locks these vulnerable places can be easily be fortified (…) It is true that some people have counselled me to treat it as part of the problem of fortification expecting a fuller description of it, but I preferred first to extract this part, so that it might not be included amongst many other matters which do not interest everybody, and thus might be read better by many and especially by those who have proper judgement to apply it in practice. To this end, your High Mightinesses, I dedicate this treatise to you, hoping that you will take in good part my good intention and I wish you a prosperous reign.

Figure 10: Figure of the "spilsluis" taken from "Nieuwe Maniere van Sterctebou, door Spilsluysen", p. 12, Konimklijke Bibliotheek van België, Kostbare Werken, VH 8489 C2 see also "Wonder en is gheen wonder", figure 4.4.

Caption: Stevin improves the construction of sluices. In "Nieuwe Maniere van Sterctebou, door Spilsluysen" Stevin gives a survey of the existing types of sluices and the way they work. The 5th form shows the new type of sluice, the "spilsluis", which was also incorporated in defence constructions in the neighbourhood of towns.

The use of "pivoted sluice-locks" or sluices with swivel-gates or mitred doors for military purposes is, for the general principles, described in 12 "Examples" of Chapter 3 of the book, their application in special cases in Chapter 4. In *"kort begryp deses handels" (*summary of this treatise) Stevin first explains in the Chapters 1 and 2 his new invention of scouring pivoted sluice locks and the consolidation of the foundations of locks and dams, respectively. In chapter 3 he really starts the description of the fortification of towns by means of the new locks. The original title of chapter 3 and 4 are:

- *inhoudende ghemeenen reghel, van der Steden nieu manier van verstercking, door schuerende Spilsluysen.* [67]
- *inhoudende voorbeelden, hoemen eenighe Steden die dadelic in wesen zijn, door de ghemeene reghelen des 3 Hooftstucx kan verstercken.*[68]

Stevin does not describe for every place in the Netherlands on an individual basis the way it can be fortified by its new sluices. His work shows Stevin's knowledge of the Dutch and many foreign fortresses and of the hydraulic engineering conditions in his country. He classifies the towns into certain categories and for each of these he presents the system of sluices which are the most favourable. He introduces on folio 57 of the book six different situations and mentions immediately the names of the towns for which his application can be introduced:

1. Towns (fortresses), situated on the sea or on a tidal water, such as Sluys, IJzendijke, Tholen, Vere, Zierikzee (all in Zeeland); Willemstad, Geertuidenberg (both in North Brabant); Rotterdam, Dortrecht (both in South Holland); Enkhuizen, Amsterdam (both in North Holland).
2. Towns situated on large non-tidal rivers, which have smaller rivers running into them, like Arnhem, Zutphen (both in Gelderland); Deventer, Zwolle (both in Overijssel).
3. Towns on a large tidal water, but so far away from it that an army camp can be pitched in between, such as Bergen op Zoom (in North Brabant); Middelburg (in Zealand); Brielle, Schiedam (both in South Holland)
4. Towns as under 3, on large, non-tidal rivers, witch have a small river running into them, such as Doesburg (in Gelderland).
5. Towns situated on large, non-tidal rivers, without having a small river running into them, such as Woudrichem, Heuden (both in North Hooland); Zaltbommel (in Gelderland); Kampen (in Overijseel); Emmerik, Rees (both on the Rhine in Germany and at that time fortresses of the Republic).
6. Towns far from large waters, but on small, mostly unnavigable rivers, such as Bredevoort (in Gelderland); Meurs (on the Rhine); The Hague, Breda and the like.

For each of the categories Stevin suggests improvements, where one or pairs of pivoted sluice locks so-called *ravelins*, additional ditches, if necessary additional forts, etc.. have to be added to the actual construction. Following Schukking Stevin has probably failed to reap

[67] Containing the general rule of the new manner of fortifying towns by means of scouring pivoted sluice locks.
[68] Containing examples of how certain existing cities might be fortified by the general rules laid down in chapter3.

immediate success with his meritorious proposals and designs. He mentioned that it would certainly be worth the trouble to find out whether afterwards perhaps pivoted sluice locks, either for inundation or as lift lock, have been applied in Dutch fortresses. In a footnote Schukking remarks that Bergen op Zoom, Grave, Sas van Gent, Vlissingen (Flushing), Brielle, Gorinchem, Hellevoetsluis and Willemstad were provided with sluices as mentioned by Stevin.

9. Conclusions.

Stevin starts in many cases with mathematical calculations to introduce motivated changes to existing fortifications. As an author of the first Dutch work on military architecture, in which he adapts the Italian system of constructing fortresses to the situations in the Low Countries, Stevin can be considered important in the history of the construction of fortifications. Sometimes the budget of the Republic did not allow the introduction of the suggested changes, but nevertheless Prince Maurice was interested in his recommendations. Many of his ideas have been applied by successors. In an adapted form one finds many ideas back in the constructions built under the supervision of the French engineer Vauban. The way in which Prince Maurice was organizing encampment was innovating for his time. Stevin has described Maurice's ideas in a very pedagogical way and his writings, translated very soon in different European languages, formed the basis for numerous later military campaigns in Europe.

Appendix: Works of Stevin present in the Legermuseum at Delft.

The collection of works of Stevin present at the Legermuseum is mainly oriented to books and manuscripts concerning matters of war and the army. The number of works of Stevin or attributed to Stevin is quite extensive. We find it worthwhile to give a short enumeration of these works with some comments.

1. *Nieuwe Maniere van Sterctebou, door Spilsluysen,* published in Rotterdam by Jan van Waesberge in 1617. Two copies present of the first print are present.
2. *Castrametatio, Dat is Legermeting*, published in Rotterdam by Jan van Waesberge in 1617 together with the work cited under 1. Three copies of the first print are present.
3. *La Castrametation,* a French version of 2., also printed by Jan van Waesberge in 1618. One copy is present.
4. *Nouvelle Maniere de fortification par escluses,* a French version of 1., also printed by Jan van Waesberge in 1618. One copy is present.
5. *Sterckten-Bouwingh,* published by Johannnes Janssonius in 1624. This is a reprint of the original work *De Stercktenbouwing*, published by François van Raveleghien in Leiden in 1594.
6. *Militaire afbeeldingen aanwijzende de Legertogten, Campementen, Logeringen, Slag-Ordres, Batalien, Fortressen, Attacques, Defensien, en andere Schikkingen der troupen te Velde Zoo te paarde als te voet Onder de Princen van Orangen, en de Leger vanden Staat gebruykelyk* (Military illustrations, indicating the Campaigns, Encampments, Quartes, Battle-arrays, Battles, Fortifications, Attacks, Defences and other Formations of Troops in the Field both Cavalry and Infantry. According to the general custom adopted by the Princes of Orange and the States Armies. It is a manuscript where folia 3-149 is written in black and red in the same hand. Folia 1 and 2, with the title on folium 1, are added later; the title is written in another (later) hand. The folia 27-45, 73-85, 112-115, 150-164 are blank. At the end, after folium 152, eight drawings and one print is added. Following Schukking (see reference 26) this manuscript was probably compiled by Stevin. One copy is present.

7. *Les Oeuvres Mathematiques de Simon Stevin de Bruges,* edited by Albert Girard Samielois and published in Leiden by Abraham and Bonaventura Elzevier in 1634. This work contains six parts on different works of Stevin. The sixth part consists of *La Castramétation*, reprint of 3., *La Fortification par Escuses,* reprint of 4. and *La Fortification*, a translation of Girard himself of 5. One copy is present.
8. Five books consisting of the five parts present in *Wisconstige Gedachtenissen* (Mathematical Memoirs), all published in Leiden by Jan Bouwensz. with the following titles and years of publication:
    a. Eerste Stuk der Wisconstighe Ghedachtenissen Van Weereltschrift (1608).
    b. Tweede Stuck der Wisconstighe Ghedachtenissen Vande Meetdaet (1605).
    c. Derde Stuck der Wisconstighe Ghedachtenissen Vande Deursichtighe (1605).
    d. Vierde Stuck der Wisconstighe Ghedachtenissen Vande Weeghconst (1605).
    e. Vyfde Stuck der Wisconstighe Ghedachtenissen Vande Ghemengde Stoffen (1608).

    Of each part one copy is present. These are all first prints
9. *Festung-Bawung*, is the translation by Gothardus Arthus of *De Stercktenbouwing,* published by Wolfgang Richter and the widow of Levinus Hulsius in 1608 in Frankfurt. This is a first print. One copy is available.
10. *De Beghinselen der Weegconst,*, published by François van Raphelinghen in Leiden in 1586. This is a first print. One copy is present.